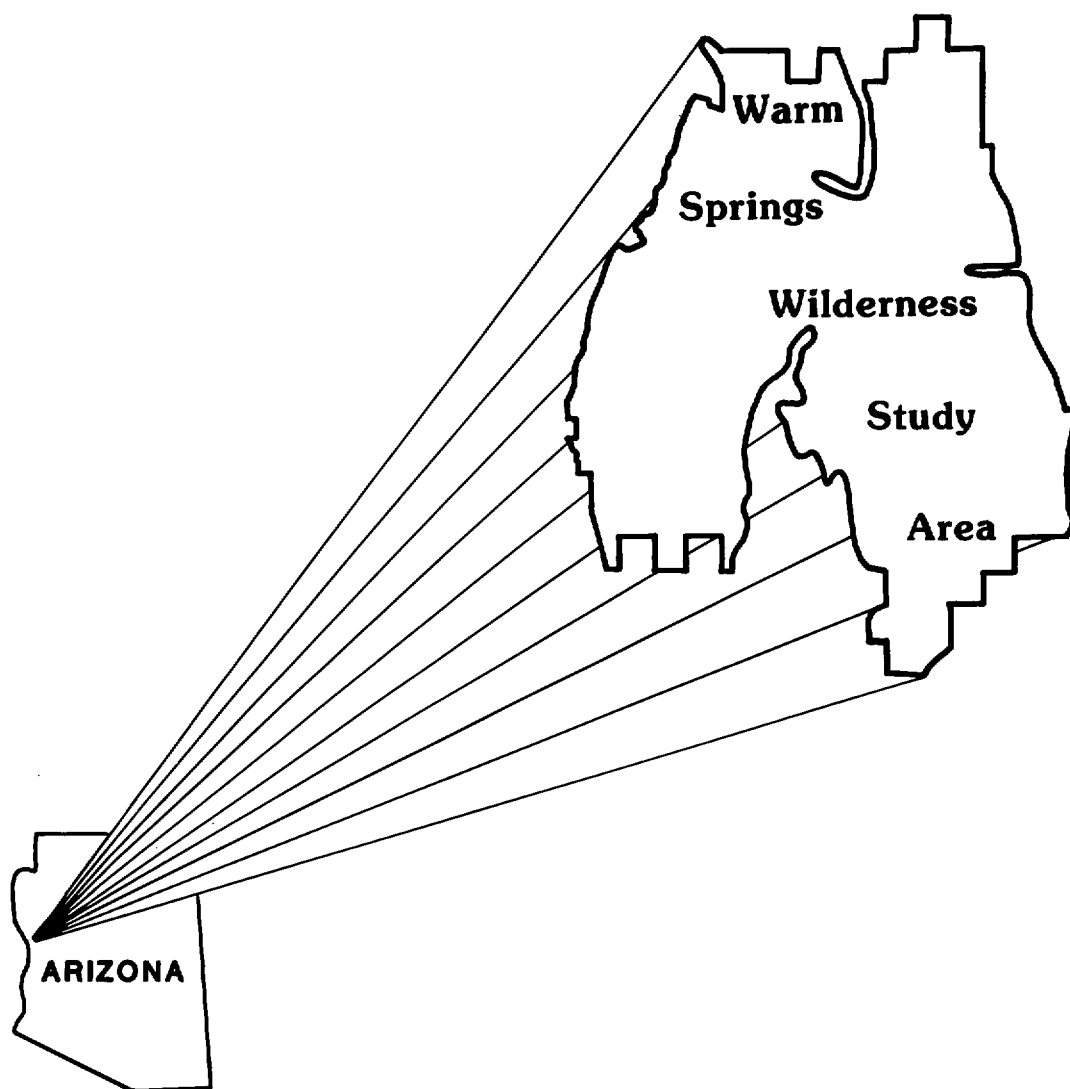




Mineral Land Assessment  
Open File Report/1988

**Mineral Resources of the Warm Springs Wilderness  
Study Area (AZ-020-028/029),  
Mohave County, Arizona**



**BUREAU OF MINES  
UNITED STATES DEPARTMENT OF THE INTERIOR**

MINERAL RESOURCES OF THE WARM SPRINGS WILDERNESS STUDY AREA  
(AZ-020-028/029), MOHAVE COUNTY, ARIZONA

by

Stanley L. Korzeb

MLA 48-88  
1988

Intermountain Field Operations Center  
Denver, Colorado

UNITED STATES DEPARTMENT OF THE INTERIOR  
Denver, Colorado

BUREAU OF MINES  
T S Ary Director

## PREFACE

The Federal Land Policy and Management Act of 1976 (Public Law 94-579) requires the U.S. Geological Survey and the U.S. Bureau of Mines to conduct mineral surveys on certain areas to determine the mineral values, if any, that may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of a mineral survey of the Warm Springs Wilderness Study Area (AZ-020-028/029), Mohave County, Arizona.

This open-file report summarizes the results of a Bureau of Mines wilderness study. The report is preliminary and has not been edited or reviewed for conformity with the Bureau of Mines editorial standards. This study was conducted by personnel from the Resource Evaluation Branch, Intermountain Field Operations Center, P.O. Box 25086, Denver Federal Center, Denver, CO 80225.

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# UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

°C	degree centigrade
°F	degree Fahrenheit
\$	dollar
ft	foot
in.	inch
Kg/m <sup>3</sup>	kilogram per cubic meter
mi	mile
meq NH <sub>4</sub> /g	milliequivalent of ammonium per gram
mg/l	milligram per liter
oz/st	ounce per short ton
ppb	part per billion
%	percent
lb/ft <sup>3</sup>	pound per cubic foot
st	short ton
ft <sup>2</sup>	square feet

MINERAL RESOURCES OF THE WARM SPRINGS WILDERNESS STUDY AREA  
(AZ-020-028/029), MOHAVE COUNTY, ARIZONA

by

Stanley L. Korzeb, Bureau of Mines

SUMMARY

In February and April 1987, the Bureau of Mines conducted a mineral investigation of the Warm Springs Wilderness Study Area, Mohave County, Arizona, on 96,300 acres of land administered by the Bureau of Land Management. The mineral investigation was requested by the Bureau of Land Management and authorized by the Federal Land Policy and Management Act of 1976 (Public Law 94-579).

Resources of zeolite and perlite were identified in the study area. An identified subeconomic clinoptilolite-mordenite zeolite deposit containing an indicated 1 million tons and an inferred 2 million tons occurs in the vicinity of McHeffy Butte. A perlite deposit in the southeast corner of the study area contains an inferred subeconomic resource of 13 million tons.

Quartz veins that have produced gold and silver extend from the Oatman district into the northwest part of the study area, where they may contain additional ore shoots at depths exceeding 2,000 ft below the surface.

Kaolin clay has been mined from the study area near the southern boundary. The remaining clay in this deposit is not a resource because it is too low a grade to be economical without beneficiation. No oil and gas or geothermal resources exist within the study area.

INTRODUCTION

In February and April 1987, the Bureau of Mines, in a cooperative program with the U.S. Geological Survey (USGS), conducted a mineral investigation of the Warm Springs Wilderness Study Area (WSA), Mohave County, Arizona, on lands

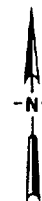
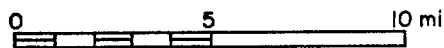
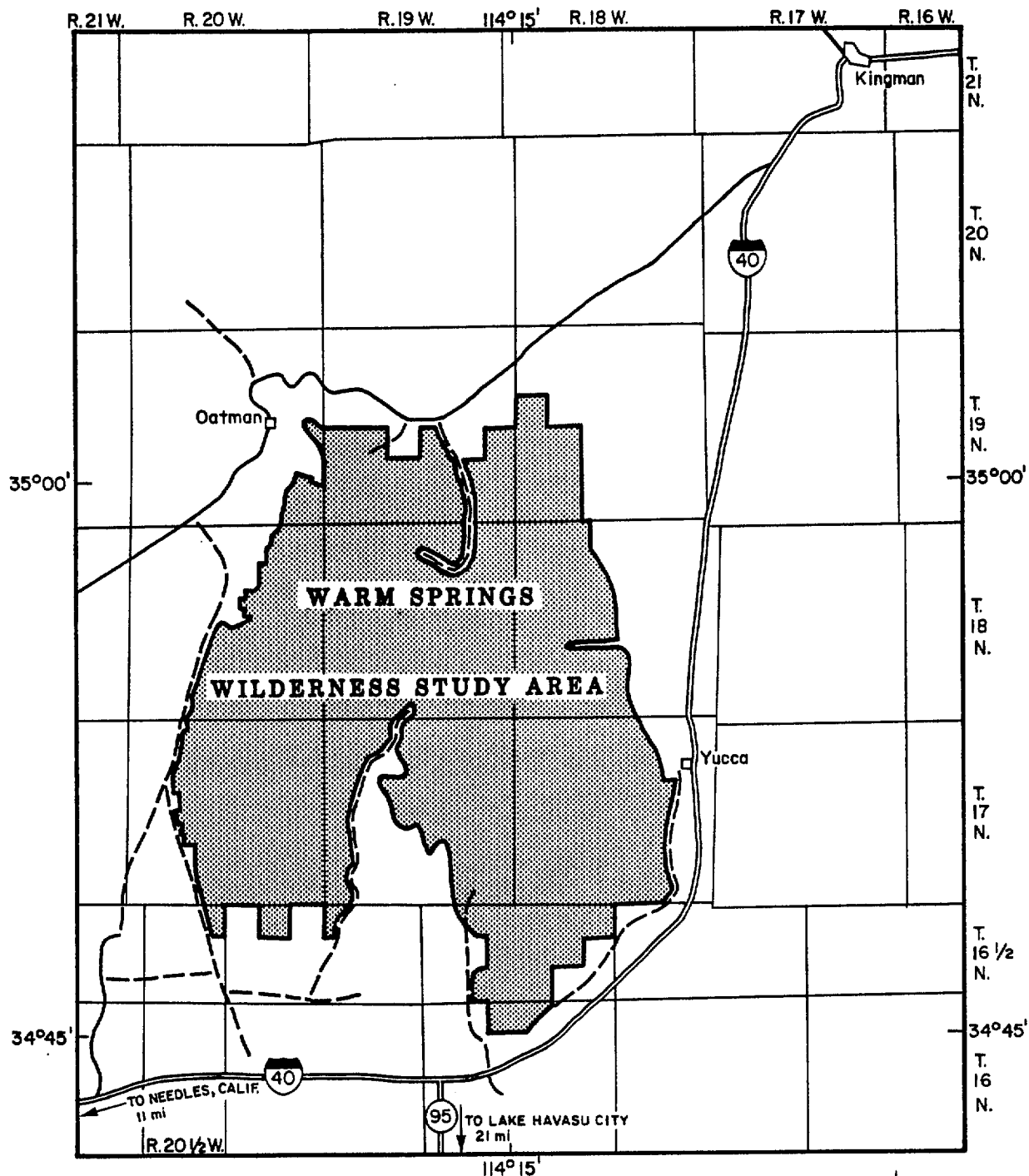
administered by the Bureau of Land Management (BLM), Phoenix District Office, Phoenix, Arizona. The Bureau surveys mines, prospects, and mineralized areas to appraise reserves and identified resources. The USGS assesses the potential for undiscovered mineral resources based on regional geological, geochemical, and geophysical surveys. This report presents the results of the Bureau of Mines study, and the USGS will publish the results of their studies. A joint report, to be published by the USGS, will integrate and summarize the results of both surveys.

#### Geographic setting

The Warm Springs WSA is 15 mi southwest of Kingman, 1 mi southeast of Oatman, and 1 mi west of Yucca, Arizona (fig. 1). A paved road extending from Interstate Highway 40 to Oatman provides access to the northern and northwestern parts of the WSA. Unimproved roads accessible from Oatman and Yucca provide access to the rest of the area. The WSA is in the Basin and Range physiographic province and encompasses 96,300 acres in the southern part of the Black Mountains. Topographic features include dissected mesas with steep sides. Elevations range from 4,360 ft near Oatman to 1,000 ft near the southern boundary.

#### Previous investigations

Geology and ore deposits in the Oatman district were first investigated by Ransome (1923) and later by Lausen (1931). Clifton, Buchanan, and Durning (1980) investigated the controls of mineralization in the Oatman district, and Durning and Buchanan (1984) did additional studies on the geology and ore deposits. Geology and mineral deposits in the WSA were investigated by the Great Basin GEM Joint Venture (1983) for the BLM.



EXPLANATION	
	INTERSTATE HIGHWAY
	STATE HIGHWAY
	IMPROVED ROAD
	UNIMPROVED ROAD

Figure 1.--Index map of the Warm Springs Wilderness Study Area, Mohave County, Arizona.

### Methods of investigation

Records at the Arizona Department of Mines and Mineral Resources and BLM state office in Phoenix were reviewed for information regarding geologic investigations, patented and unpatented mining claims, and federal mineral and oil and gas leases in and near the study area.

Three Bureau geologists spent 27 days examining the WSA. Mines were mapped by tape and compass methods. A total of 168 chip samples and 13 grab samples was taken from adits, prospects, and mineralized outcrops in and near the WSA. One hundred fifty-five samples were analyzed for gold by fire assay and atomic absorption, and for silver, arsenic, copper, lead, antimony and thallium by inductively coupled plasma-atomic emission spectroscopy. Analyses were performed by Chemex Labs Inc., Sparks, Nevada. X-ray diffraction analyses of five zeolite and fifteen clay samples were made by Colorado School of Mines Research Institute, Golden, Colorado. The five zeolite samples were tested for ammonium exchange capacity to determine suitability for uses. Six perlite samples were tested for expandability in a laboratory furnace test by The Perlite Corporation, Chester, Pennsylvania. Analytical results in this report are shown as they are reported from the laboratory, without rounding. Complete analytical data for all samples are available for public inspection at the U.S. Bureau of Mines, Intermountain Field Operations Center, Building 20, Denver Federal Center, Denver, Colorado.

### GEOLOGIC SETTING

The WSA is underlain by Precambrian granite, gneiss, and schist that host pegmatite dikes and quartz veins and crop out in the northeastern part of the area. Throughout the rest of the WSA, the Precambrian rocks are extensively overlain by thick mid-Tertiary and Quaternary volcanic sequences (Great Basin GEM joint venture, 1983, p. 10).

In the northwestern corner of the WSA, the Miocene volcanic formations are the Oatman Latite, Gold Road Latite, and an unnamed olivine basalt (Durning and Buchanan, 1984, p. 142-144). These formations are exposed along a steep escarpment of Black Mesa adjacent to the Oatman district. Olivine basalt caps the mesas throughout the study area. A number of faults, serving as channel ways for mineralizing fluids, cut the mid-Tertiary volcanic sequence. Many of these faults host quartz veins containing gold.

#### ENERGY RESOURCES

Oil and gas leases occur in the WSA (pl. 1) but no exploratory holes have been drilled in or near the area. Ryder (1983) has rated the area as having a low to zero potential for petroleum accumulations because the study area consists of Precambrian rocks overlain by mid-Tertiary volcanics.

Two warm water seeps known as Warm Springs, sec. 33, T. 18 N., R. 19 W. near the center of the WSA (pl. 1), are reported to have a temperature of 33° C and 27° C. Generally, thermal waters are enriched in lithium, chloride, and boron; in contrast, cold meteoric waters are lacking high concentrations of these elements. The water at Warm Springs contained only background concentrations of lithium (<0.02 mg/l), boron (0.13 mg/l), and chloride (32 mg/l). Warm Springs is chemically more similar to cold meteoric waters than to thermal waters. Based on the low discharge temperature and background concentrations of lithium, chloride, and boron, Warm Springs probably does not contain any water of deep thermal origin. (See Goff, 1979, p. 7-20.) No geothermal resource was identified in the WSA.

#### MINING HISTORY

The WSA is adjacent to the Oatman mining district. Veins with gold production extend from the district into the study area. Gold was first

discovered in 1863 in the Moss vein northwest of Oatman; shortly thereafter, other prominent veins cropping out southwest of Oatman were discovered. The Gold Road vein was discovered in 1900 and the Tom Reed vein in 1901. In 1906, the Tip Top and Ben Harrison orebodies were discovered on the Tom Reed vein, and in 1916, the Big Jim and Aztec orebodies were discovered at the southeastern end of the vein. The United Eastern orebody at the western end of the Tom Reed vein was discovered in 1916. (See Clifton, Buchanan, and Durning, 1980, p. 5-6.)

The United Eastern orebody was exhausted in 1924 after producing 550,000 st of ore with an average grade of 1.1 oz gold/st. The Gold Road Mine stayed in production until 1942, and produced 1,513,823 st of ore with a grade of 0.32 oz gold/st. Between 1897 and 1942, total production for the district was 2.2 million ounces of gold and 0.8 million ounces of silver from 3.8 million tons of ore with an average grade of 0.58 oz gold/st and 0.17 oz silver/st. (See Clifton, Buchanan, and Durning, 1980, p. 5-6.) The 1988 dollar value for gold and silver produced from the Oatman district is \$891 million gold and \$5 million silver.

In 1979, Fischer-Watt Mining Company conducted a detailed study of the Oatman district in order to define new exploration targets. This investigation identified several unexplored targets that were evaluated by 42,000 ft of hammer and core drilling on the Tom Reed vein. The drilling program identified a moderate tonnage of 0.20 oz gold/st. (See Durning and Buchanan, 1984, p. 142.)

In 1979, Occidental Minerals Corporation conducted a reconnaissance study for zeolites within the WSA near McHeffy Butte. As a result of their study, Occidental staked a block of claims on a possible clinoptilolite, mixed

clinoptilolite-mordenite deposit with a large tonnage potential. In 1982, Occidental sold the claims to Phelps Dodge Zeolite Corporation, which explored the property by drilling and prospect pits. In October, 1985, the property was sold to Tenneco, Inc. Steelhead Resources, the present owner, purchased the claims from Tenneco Inc. in December, 1987 (U.S. Bureau of Mines unpublished records).

#### APPRAISAL OF SITES EXAMINED

Quartz veins, which have produced gold and silver, extend into the WSA from the Oatman mining district and were examined for gold and silver. Commercial grade zeolite and perlite deposits were identified within the WSA.

#### Gold- and silver-bearing veins

Gold-bearing quartz veins extend into the WSA from the Oatman district. The vein extensions in the WSA have mineralogic and textural characteristics similar to the ore zones as described by Durning and Buchanan (1984). The following general description of the veins in the Oatman district is based on Durning and Buchanan's investigations.

The veins are quartz-, calcite-, adularia-, chlorite-, and electrum-filled faults, with ore confined to shoots within barren to sub-ore grade quartz. Most veins show pre-ore faulting, which created the original fracture, and post-ore fault movement. Mineralization did not occur equally along the strike and dip; zones of gouge and breccia separate zones of quartz and calcite. Most of the ore shoots are zones of quartz and calcite veins and veinlets cutting through blocks of silicified latite.

Quartz in the veins occurs in five stages and varies in gold content, color, and banding. In the first two stages, the quartz is generally colorless, white or amethystine, and coarse to fine grained. The gold content

is generally low ranging from undetected to 0.008 oz/st. The third, less common stage, is fine grained, banded, and variable in color. Gold content of the third stage ranges from 0.06 oz/st to 0.40 oz/st. The fourth and fifth quartz stages contain gold concentrations between 0.2 oz/st and greater than 1.0 oz/st and are abundant only in ore shoots. Quartz in these final stages is pale green, yellow to deep honey yellow, fine to medium grained, and usually banded. (See Durning and Buchanan, 1984, p. 152-153.)

Within the fault zones, the ore shoots are restricted to the northwestern flanks of concave-east bends occupying dilatant zones. Ore shoots in the Oatman Latite are wider and higher grade than those hosted by the Gold Road Latite which are narrow but more continuously mineralized. (See Durning and Buchanan, 1984, p. 141.) The ore-producing horizons within the veins are higher in elevation and wider when near or slightly northeast of Oatman. East of Oatman, the ore producing horizons are deeper in the veins and thinner. The top of the ore producing horizons forms a dome east of Oatman with the highest elevation being 2,800 ft above sea level. The elevations of these horizons drop to 2,100 ft above sea level west and east of the dome crest. (See Clifton, Buchanan, and Durning, 1980, p. 38-39.)

Within the WSA, the veins are not exposed because of an olivine basalt cap or are poorly exposed due to the weak surface expression at higher elevations. The surface expressions of the veins are reduced to patches of altered latite with stringers of chalcedony and areas of altered latite and chalcedony residuum. The best exposures of the veins were found along the western boundary and in the vicinity of the Cook Mine within the WSA (pl. 1, sample locations 1-116). The veins are discussed by groups from north to south along the west boundary of the WSA. The groups of veins discussed are:

Gold Road; locations 8-18, 19-49; Cook Mine and vicinity; and locations 135-159 (pl. 1).

The Gold Road vein trends toward the WSA (fig. 2) and may extend into the area at depth. On the surface at the lowest elevation outside the study area, the vein is 6 ft wide and made up of massive, banded finely crystalline white, light-green, red-brown, or gray quartz. As the vein extends toward the WSA, the surface expression changes to brecciated, silicified, and argillized latite, and white quartz stringers. Near the study area boundary, the surface expression of the vein is massive, altered latite with white chalcedony bands and stringers.

The Gold Road vein was sampled from lowest to highest elevations outside the study area (pl. 1, localities 1-5). These samples suggest that the gold content of the vein decreases as elevation increases (table 1, nos. 1-5). At the lower elevations, the gold content ranges from 1,200 ppb (0.035 oz/st) to 0.488 oz/st; at higher elevations, the gold content decreases to 30-115 ppb, and at the highest exposure the gold content was 5 ppb. Based on the elevation of the known ore horizons and geologic projection, if the Gold Road vein extends into the WSA, ore shoots in the vein will probably be more than 2,000 ft below the surface.

The veins sampled at localities 8-18 (pl. 1) contained low gold concentrations, ranging from below detection to 2,400 ppb (0.07 oz/st) (table 1). The surface exposures can be as much as 1,000 ft above the known producing ore horizons. All these veins extend into the WSA and could contain ore shoots at depth. In the WSA, at sample locality 12, latite, partially altered to white clay, exposed in a prospect pit contains 50 ppb gold (table 1), and may be a surface expression of a deep vein.

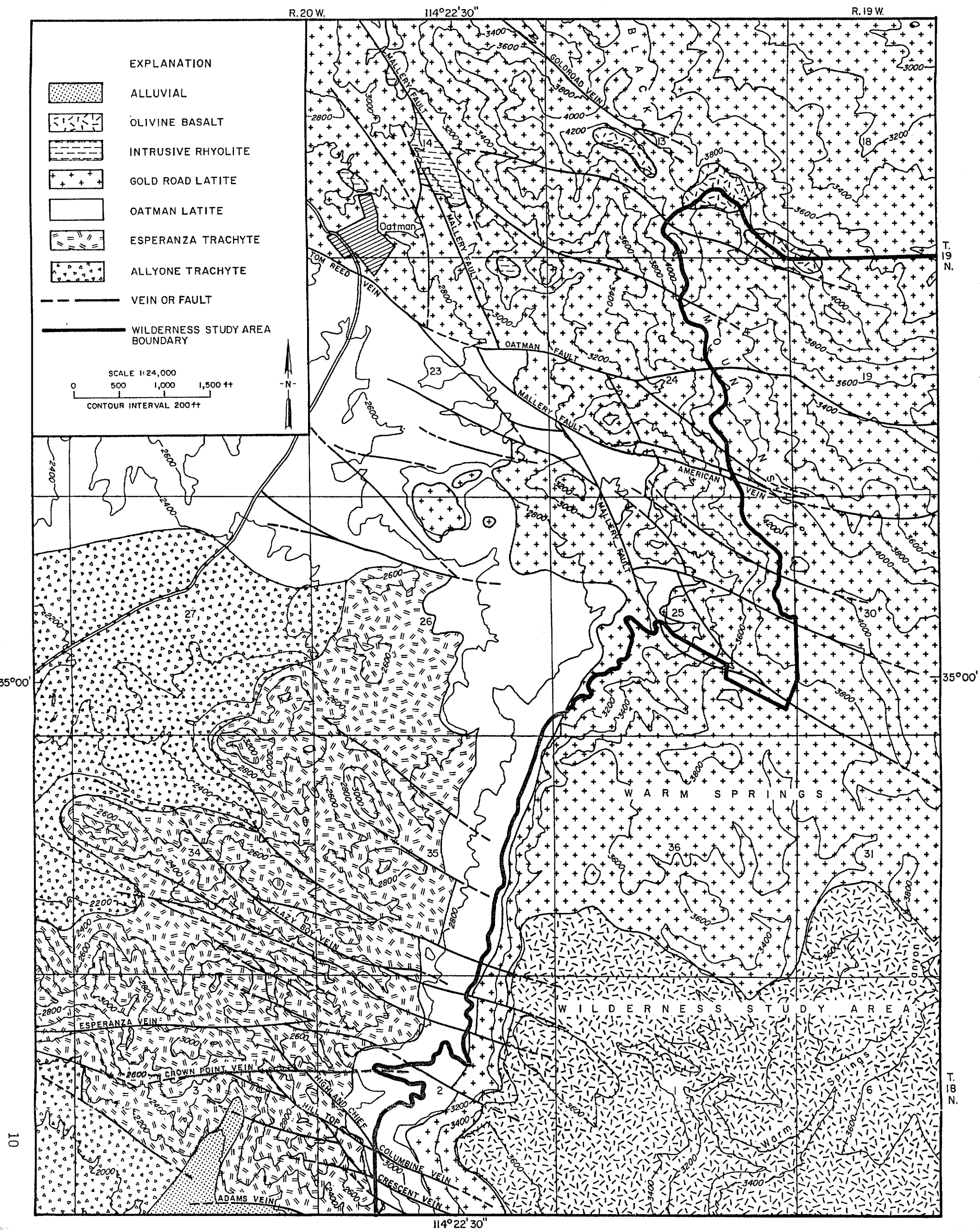


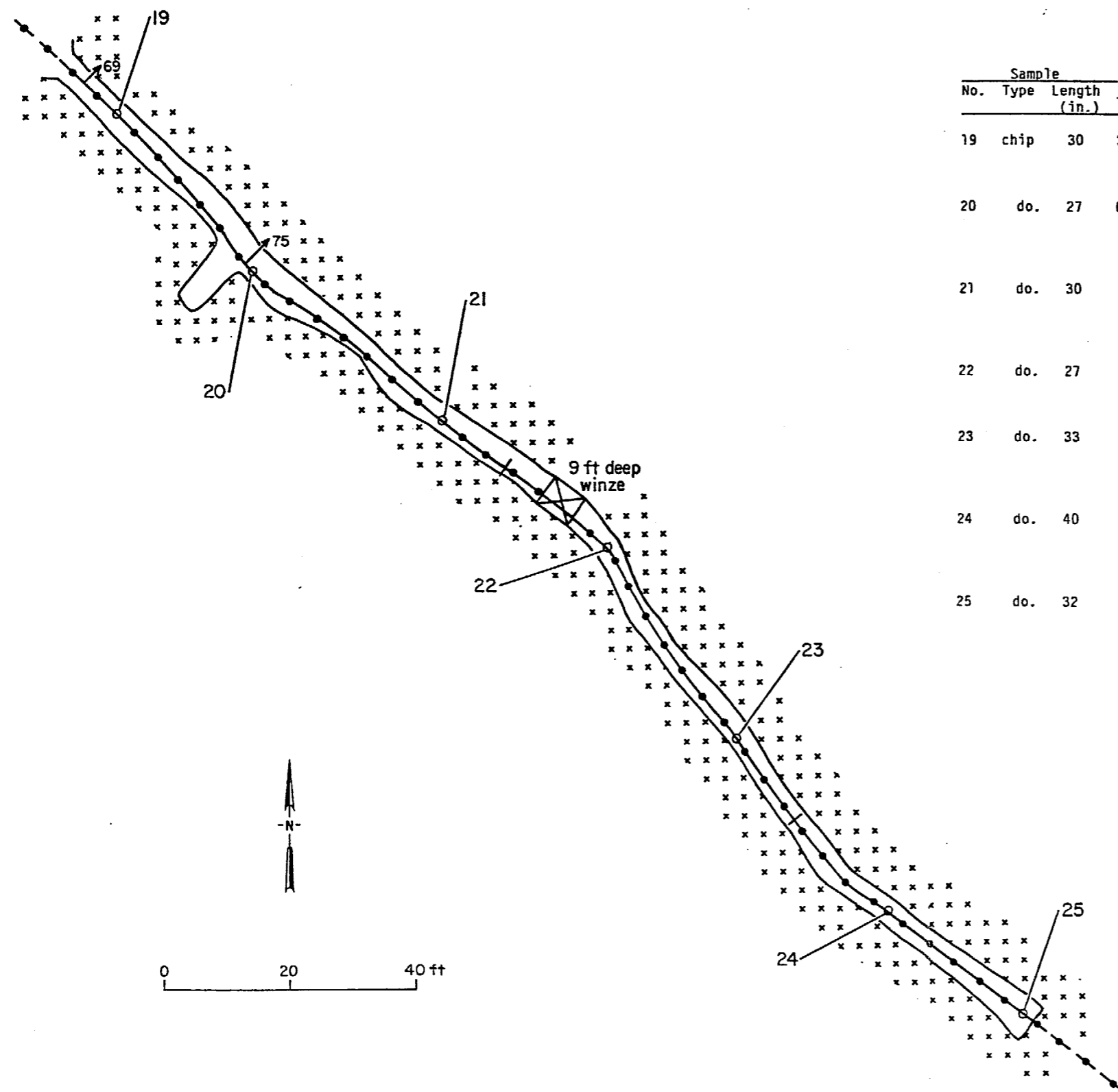
Figure 2.--Geologic map of the Oatman District showing the relationship of the veins and formations to the northwest corner of the study area (Ransome, 1923, p. 9).

Veins extending into the study area along the west boundary (pl. 1, localities 19-49) have gold contents from undetected to 6,700 ppb (0.2 oz/st) outside the study area (table 1, 2, fig. 3). Near the western boundary, outside the WSA, samples from the Wrigley Mine (pl. 1, localities 19-25, fig. 3) contained gold concentrations ranging from 75-6,700 ppb (to 0.2 oz/st). The vein exposed in this mine, the Highland Chief vein, consists of finely crystalline white quartz in a brecciated latite that is partially altered to white clay and silicified. The quartz in this vein is characteristic of the earlier quartz stages. Within the study area, the surface expression of this vein exhibits white quartz and calcite banding (fig. 4) and has a gold content of 175 ppb (table 1, no. 28).

The Highland Chief vein intersects the Columbine vein inside the study area (fig. 2). The Columbine vein is exposed in an adit 700 ft south and 200 ft below the Wrigley Mine (pl. 1, localities 29-44, pl. 2). Underground, the vein structure is a fault zone 20 to 40 ft wide filled with brecciated and silicified trachyte and quartz and calcite stringers. Gold contents of samples were low, varying from 25 ppb to 720 ppb (table 2). This section of the Columbine vein represents a brecciated barren section similar to the brecciated sections described by Durning and Buchanan (1984).

No gold or silver resources were identified in the surface exposures of the veins that extend into the WSA. However, there are surface indications that a gold resource may exist at depth in these veins. Subsurface exploration to depths over 2,000 ft will be required to determine if a gold resource is present in the WSA.

Within the WSA, the Cook Mine (pl. 1, localities 50-104, pl. 3) and a number of veins (localities 105-116) are exposed in altered latite. Samples



Sample										Sample description
No.	Type	Length (in.)	Au ppb	Ag	As	Cu ppm	Pb	Sb	Tl	
19	chip	30	3,400	0.7	22	10	8	218	0.7	Vein, 6 in. wide, white finely crystalline quartz, in highly brecciated latite, altered to white clay, minor chlorite and hematite.
20	do.	27	6,700	1.5	50	11	18	3.6	1.7	Vein, 27 in. wide, white finely crystalline quartz with pink banding, silicified latite adjacent to vein, feldspars altered to white clay.
21	do.	30	75	.3	19	12	22	10	1.2	Vein, 30 in. wide, massive, finely crystalline, brecciated quartz with red and white banding, brecciated latite adjacent to vein, feldspars altered to white clay.
22	do.	27	210	2.9	1	3	4	1.4	.6	Vein, 27 in. wide, massive, white, finely crystalline, brecciated quartz with minor green banding minor hematite, calcite, and white clay.
23	do.	33	810	1.3	2	3	6	24	.5	Vein, 33 in. wide, massive, white, finely crystalline, fractured quartz with minor calcite and hematite, brecciated latite adjacent to vein with minor white clay.
24	do.	40	500	1.9	2	3	5	3	.4	Vein, 40 in. wide, massive, white, finely crystalline, fractured white quartz with minor green banding and calcite, brecciated, silicified latite adjacent to vein.
25	do.	32	765	1.4	2	4	14	3.6	.3	Vein, 32 in. wide, 12 in. calcite seam and 20 in. finely crystalline fractured white quartz seam with green banding, brecciated, silicified latite adjacent to vein.

Figure 3.--Wrigley Mine showing sample localities 19-25, table shows sample data.

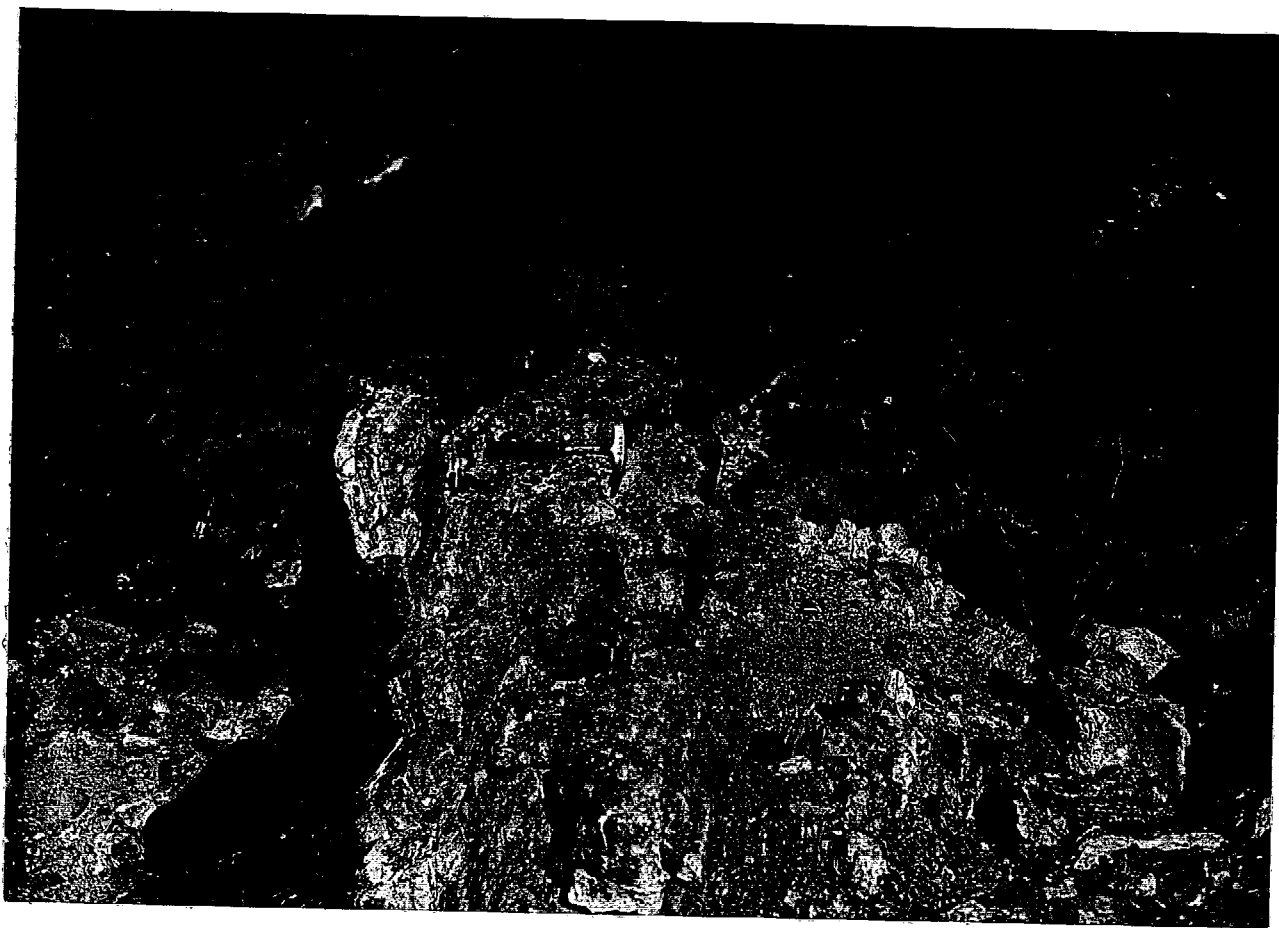
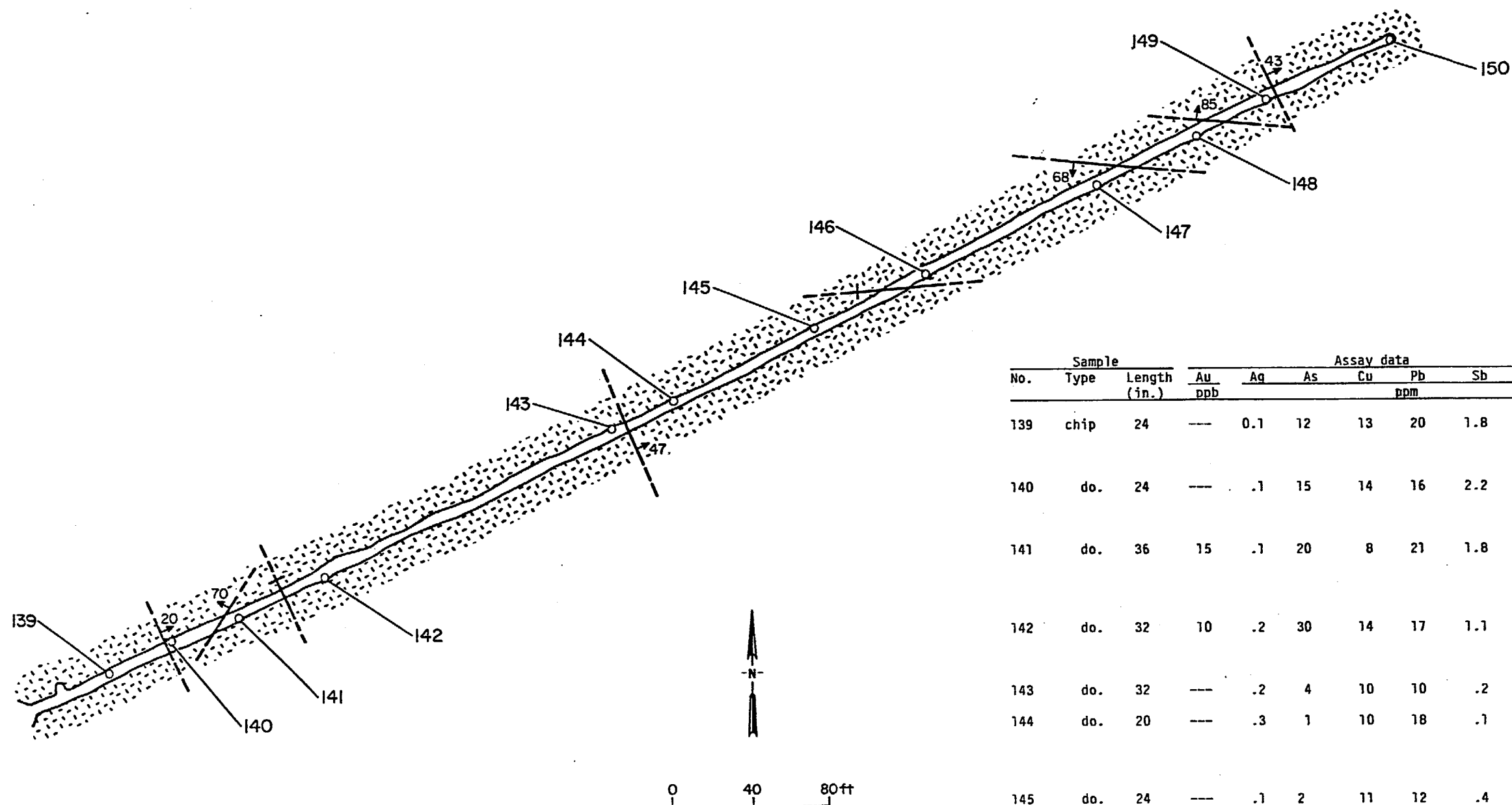


Figure 4.--Outcrop of Wrigley vein within the Warm Spring study area showing abundant calcite and brown to white quartz banding.

from veins and faults exposed in the Cook Mine contain gold from below detection to 0.258 oz/st (table 3). One vein, sample localities 78-80 and 88-104 had the highest gold content, 0.002 oz/st to 0.258 oz/st, and is composed of a finely crystalline white quartz and stringers and bands of light-green and red-brown quartz. The vein width varies from 8 in. to 42 in. along a strike length of 68 ft. The vein may contain 225 st of quartz with an average grade of 0.018 oz gold/st. The grade and tonnage is too low to be considered economic. Parts of this vein that are unmineralized are a fault filled with brecciated and silicified latite and pods and stringers of white quartz.

In the Cook Mine, the light-green and red-brown quartz banding may be an indication of fourth and fifth stage quartz mineralization. The vein is hosted by the Gold Road Latite and is at an elevation of 2,360 ft above sea level. If the vein exposed in the Cook Mine represents the top of an ore shoot, the vein may continue as an ore shoot in the Oatman Latite about 500 ft below the existing mine workings.

An area of rhyolite altered to white clay and a vein exposed on the surface occurs in the central part of the WSA (pl. 1, localities 135-159). Samples from this area of the altered rhyolite showed low gold content, ranging from undetected to 15 ppb (table 1). An adit (fig. 5) driven into the altered rhyolite exposed no mineralized structure. The vein exposed on the surface (pl. 1, localities 151-159) consisted of brecciated and silicified rhyolite and white quartz stringers. Three samples out of nine had detectable gold content, ranging from 5-15 ppb (table 1, nos. 151-159). This vein doesn't extend to or can be geologically projected to the gold mineralization of the Oatman district and represents an isolated occurrence. The low gold



No.	Sample		Assay data							Sample description
	Type	Length (in.)	Au ppb	Ag	As	Cu ppm	Pb	Sb	Tl	
139	chip	24	---	0.1	12	13	20	1.8	0.2	Rhyolite altered to massive white clay with disseminated pyrite, chert stringers and abundant limonite.
140	do.	24	---	.1	15	14	16	2.2	.2	Rhyolite partially altered to white clay, lithic fragments completely altered to white clay.
141	do.	36	15	.1	20	8	21	1.8	.5	Rhyolite altered to massive light gray clay with disseminated pyrite and minor silicification, abundant limonite.
142	do.	32	10	.2	30	14	17	1.1	.2	Rhyolite partially altered to light gray clay, lithic fragments altered to white clay, minor limonite.
143	do.	32	---	.2	4	10	10	.2	.2	Do.
144	do.	20	---	.3	1	10	18	.1	.2	Rhyolite altered to light gray clay, lithic fragments altered to white clay, disseminated pyrite, abundant limonite.
145	do.	24	---	.1	2	11	12	.4	.2	Do.
146	do.	20	---	.1	6	9	18	.4	.1	Rhyolite partially altered to white clay, pods of limonite, lithic fragments completely altered to white clay.
147	do.	28	---	.1	5	8	28	.7	.1	Do.
148	do.	34	---	.1	2	10	18	.2	.2	Rhyolite partially altered to dark gray clay, lithic fragments altered to white clay.
149	do.	24	---	.1	5	9	10	.6	.1	Rhyolite altered to light gray clay, abundant limonite.
150	do.	48	---	.1	2	14	15	.8	.2	Rhyolite partially altered to light gray clay, zones of abundant limonite.

Figure 5.--Adit showing sample localities 139-150, table shows sample data.

content indicates that it is unlikely a significant gold-bearing vein will exist at depth at this location.

In the northeastern part of the WSA (pl. 1, localities 124-133), pegmatite pods approximately 10 ft by 2 ft in area hosted by Precambrian gneiss contain detectable gold. The gold content is as much as 1,450 ppb (0.04 oz/st; table 1, nos. 124-133). Due to the small size and erratic distribution of the pegmatite pods and low gold content, a gold resource in pegmatites could not be identified in this vicinity.

#### Zeolite

A zeolite deposit lies within the WSA in the vicinity of McHeffy Butte (pl. 1, localities 117-120 and 123). Zeolite minerals are crystalline aluminosilicates of the alkaline-earth metals (Clifton, 1987, p. 1). The commercial applications of zeolite minerals make use of four basic physical and chemical properties: ion exchange capacity, adsorption and related molecular-sieve phenomena, dehydration and rehydration, and a siliceous composition (Mumpton, 1983, p. 1420). Some zeolite applications are in: molecular separations based on sieving or ion selectivity, purification, bulk separations, ammonia removal, metal separations from waste water, radioisotope removal and storage, detergent builder, aquaculture, ion-exchange fertilizers, and catalysts used by the petroleum industry (Clifton, 1987, p. 16-17).

Because of the wide variety of specialized uses for zeolites, each known zeolite deposit is characterized for a specific use. Before a zeolite deposit is developed on a commercial scale, an extensive testing program is carried out. The zeolite minerals making up a deposit are tested for each known specific use. This testing program may take as much as five years to complete before the deposit can be evaluated for its specific use, marketability, and

economics. Because zeolite deposits have specialized uses and limited markets, they often are not mined continuously on a yearly basis but are mined intermittently depending on the demand for a zeolite with specific properties. The price of zeolites is as varied as the uses and ranges from \$56.00 to \$400.00 per ton (G. Teauke, Teauke Industrial Minerals, Oregon, oral commun., 1988).

The zeolite deposit within the WSA is a clinoptilolite-mordenite deposit. Occidental Minerals Corporation and Phelps Dodge Zeolites Corporation conducted a limited investigation on the deposit, which consisted of drilling, and the determination of ammonium exchange capacity and percentages of clinoptilolite and mordenite. The drilling identified an indicated resource of one million st with an inferred resource of two million st of zeolite minerals (resource classification based on Bureau of Mines Circular 831). The ammonium exchange capacity ranged from 0.79 meq  $\text{NH}_4/\text{g}$  to 1.72 meq  $\text{NH}_4/\text{g}$  and the zeolite content varied from 55% to 75%. Samples taken and analyzed by the Bureau showed similar results; the ammonium exchange capacity ranged from 1.1 meq  $\text{NH}_4/\text{g}$  to 1.3 meq  $\text{NH}_4/\text{g}$  and the zeolite content ranged from 45% to 70% (table 4). The grade of the zeolite minerals is too low for use in ammonium adsorption.

Average ammonium exchange capacities have to be over 1.6 meq  $\text{NH}_4/\text{g}$  to be used for ammonium adsorption (Edwin H. Bentzen III, Colorado School of Mines Research Institute, written commun., 1987). The clinoptilolite-mordenite in this deposit does not meet exchange capacity standard and is not suitable for ammonia adsorption but it may be suitable for one of the other numerous uses such as ion exchange in soil conditioning. Because zeolite minerals are sensitive to dehydration and rehydration and ion exchange, samples taken from

prospects on the surface may not be representative of the true properties of the unweathered zeolite. Further evaluation of this deposit will require the collection of unweathered samples and an extensive testing program for all the possible uses of clinoptilolite-mordenite (G. Teauke, Teauke Industrial Minerals, Oregon, oral commun., 1988). According to Dan Robertson (Steelhead Resources, Spokane Washington, oral commun., 1988) Steelhead Resources, the present holder of the claims, is planning to conduct further investigations on the zeolite deposit at McHeffy Butte.

#### Kaolin

An unknown amount of kaolin was mined from the WSA in the 1960's (pl. 1, localities 161-169). The deposit was mined by surface pit from two 20-ft benches (fig. 6). Samples taken within the pit were analyzed by x-ray diffraction and showed 7% to 10% kaolinite and 0% to 70% clinoptilolite-mordenite (table 5). Most economical kaolin deposits are essentially pure and require little preparation for market. Deposits containing 10% or less kaolinite must be washed and concentrated to obtain marketable kaolin (Patterson and Murray, 1983, p. 612). The nearest processing plants are in Georgia. The remaining clay deposit within the WSA contains 97,000 st and is of too low a grade and too far from commercial markets and a processing plant to be economical. The zeolite content in the clay is too low and erratically distributed to justify further investigations for a possible zeolite resource.

#### Perlite

A number of volcanic glasses within the WSA (pl. 1, localities 176-181) were tested for perlite. Perlite is a hydrated rhyolitic (volcanic) glass that contains from 5% to 25% combined water and can be expanded into a light weight aggregate by heating (Kadey, 1983, p. 997). Perlite can expand from

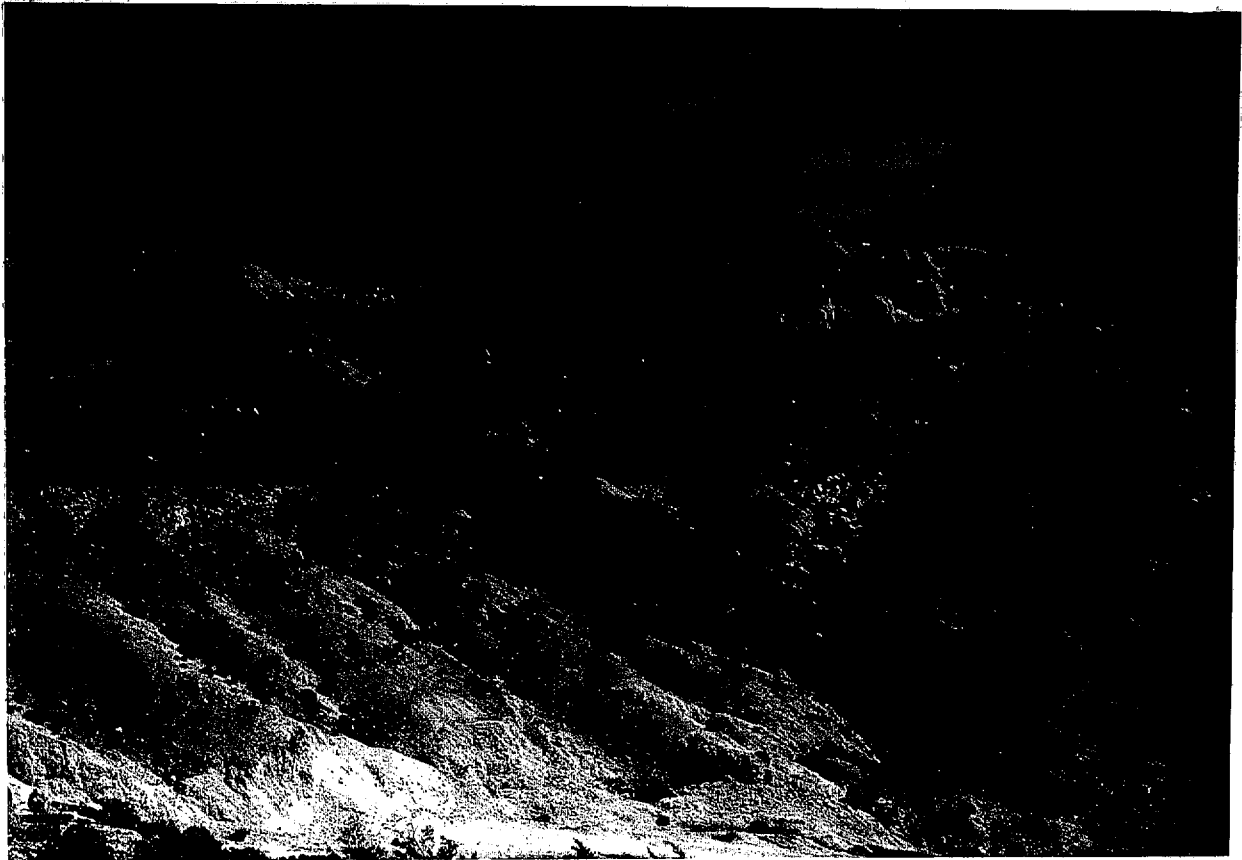


Figure 6.--Kaolin quarry within the Warm Springs study area in sec 36, T. 17 N., R. 19 W. (photo by Richard Kness, 1987).

4 to 20 times its original volume when heated to temperatures between 1,400° to 2,000° F. Expanded perlite can be a white fluffy highly porous material or glazed glassy particles having a low porosity. The properties that make processed perlite a desirable industrial material are its low bulk density, large surface area of its particles, low thermal conductivity, high resistance to fire, and low sound transmission. The industrial uses for perlite include abrasives, acoustical plaster and tile, cleanser base, concrete construction aggregates, filter aid, fertilizer extender, inert carrier, insulation board filler, loose fill insulation, paint texturizer, pipe insulator, plaster aggregate and texturizer, propagating cuttings for plants, refractory products, soil conditioner, tile mortar aggregate and light weight insulating concrete for roof-decks, and wallboard core filler (Meisinger, 1975, p. 783-784). Uses for perlite of different densities are as follows: product lighter than 40 kg/m<sup>3</sup> is useful for filter aid, board, and cryogenics; 50 kg/m<sup>3</sup> is good for plaster and concrete aggregate, filter aid, wall board, and cryogenics; 60 to 100 kg/m<sup>3</sup> possibly good for plaster and concrete aggregate but will require higher fuel consumption to expand than the best U.S. ore; 110 kg/m<sup>3</sup> probably good for plaster and concrete aggregate but will require high heat to expand; densities higher than 180 kg/m<sup>3</sup> is not commercial for any use (Arthur D. Anderson, The Perlite Corporation, Chester, Pennsylvania, written commun., 1988).

Samples 176 to 179 (table 6) from the study area all had densities exceeding 180 kg/m<sup>3</sup> and therefore have no commercial value. Sample 180 and 181 had densities ranging from 33 to 80 kg/m<sup>3</sup> (table 6) and can be used for filter aid, wall board, cryogenics and possibly plaster and concrete aggregate.

An inferred subeconomic resource of 13 million st was calculated from a thickness of 20 ft and an area of 9 million ft<sup>2</sup> using a tonnage factor of 13.9 or a density of 144 lb/ft<sup>3</sup> (Gese, 1985, p. 4). The value of perlite ore at the mine ranges from \$35 to \$50 per ton and averages \$45 per ton depending on grade and intended use (Arthur D. Anderson, The Perlite Corporation, Chester, Pennsylvania, oral commun., 1988).

An accurate dollar value cannot be placed on the deposit in the WSA because no information on subsurface continuity or quality is available. The estimated tonnage would have to be confirmed and material tested to determine its expansion consistency throughout the deposit. A commercial furnace test would need to be conducted using 4 to 8 tons of material. The nearest market for the type of perlite found in this deposit is in the vicinity of Los Angeles, California. Rail transportation lies within 1/4 mi of the deposit. Based on the Bureau's limited sampling and tonnage estimates the deposit could be worth \$585 million minus mining and other costs.

#### CONCLUSIONS

Identified resources for zeolite, perlite, and gold were found in the WSA. Quartz veins in the Oatman district with past gold production project into the WSA, and ore shoots may extend 2,000 ft or more below the surface of the study area. An inferred subeconomic resource of gold in 225 st of quartz having a grade of 0.018 oz gold/st was found in the Cook Mine in the WSA. A zeolite deposit within the study area in the vicinity of McHeffy Butte is an identified subeconomic resource containing an indicated 1 million st and an inferred 2 million st of clinoptilolite-mordenite. Further testing of unweathered material is needed to characterize this deposit and to determine the specific uses for the zeolite minerals it contains. In the southeast

corner of the WSA is an inferred subeconomic resource of perlite. Perlite from this deposit may be useful as a filter aid and may become an important source for this material in the future. No kaolin, petroleum, or geothermal resources are known to exist in the WSA.

#### RECOMMENDATIONS

Further, more detailed investigations including drilling would be needed to place accurate dollar values on the zeolite and perlite deposits within the WSA. Subsurface investigations are needed to determine if ore shoots containing gold are present in the veins that extend into the WSA from the Oatman district.

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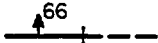
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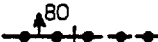
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# EXPLANATION OF SYMBOLS FOR FIGURES 3 and 5

 45 SAMPLE LOCALITY--showing sample number


 66 FAULT--showing strike and dip; dashed where approximate

 80 VEIN--showing strike and dip; dashed where approximate

 WINZE TOP

 PORTAL

## LITHOLOGY

 LATITE

 TRACHYTE

 ALTERED RHYOLITE

Table 1.—Analytical data and description of samples for gold prospects in and near the Warm Springs Wilderness Study Area, Arizona, not shown in other figures or tables.

[Gold and silver determined by fire assay and atomic absorption; antimony, arsenic, copper, lead, and thallium determined by inductively coupled plasma analysis. Au, gold; Ag, silver; As, arsenic; Cu, copper; Pb, lead; Sb, antimony; Tl, Thallium. ---, analyzed for but below detection limit. Detection limits: Au, 5 ppb and 0.001 oz/st; Ag, 0.1 ppm; As, 1 ppm; Cu, 0.1 ppm; Pb, 0.1 ppm; Sb, 0.2 ppm; Tl, 0.1 ppm; xxx, not applicable.]

No.	Sample		Assay data							Sample description
	Type	Length (in.)	Au ppb	Ag	As	Cu	Pb	Sb	Tl	
1	Chip	36	1,200	0.5	24	8	8	2.8	0.8	Vein, finely crystalline white quartz, with light-green, red-brown, and gray quartz bands, red-brown brecciated and silicified latite.
2	do.	13	0.488 oz/st	10.5	60	32	21	4.0	.6	Vein, finely crystalline white quartz, with green and gray quartz bands, minor dark-brown quartz band containing hematite.
3	do.	42	115	.1	110	21	19	6.0	1.8	Vein, brecciated and silicified latite, white quartz stringers in fractures, latite adjacent to vein partially altered to white clay, abundant hematite in fractures.
4	do.	24	30	.1	7	7	17	10.4	.8	Vein, brecciated and silicified latite, white quartz stringers, latite adjacent to vein altered to white clay and minor chlorite, abundant hematite in fractures.
5	Grab	xxx	5	.1	2	3	8	.4	.1	Vein material float, pieces up to 2 ft across of brecciated and silicified latite with white and gray chalcedony bands.
6	do.	xxx	5	.1	2	10	15	.4	.2	Latite altered to light gray clay and chlorite.
7	Chip	30	---	.1	2	12	7	.4	.4	Vein outcrop, partially silicified latite and white chalcedony, latite altered to light gray and pink clay, adjacent to vein.
8	do.	48	2,400	3.2	45	15	15	28	1.2	Vein, brecciated latite altered to gray clay, brecciated coarsely crystalline white quartz, white calcite, calcite partially to completely replaced by white quartz, quartz stringers extend into adjacent latite.
9	do.	36	---	.1	2	6	3	1.4	.2	Latite partially altered to light gray clay, feldspars altered to white clay, minor calcite in fractures.
10	Grab	xxx	250	2.4	16	5	5	.8	.1	Select dump sample of vein material, coarsely crystalline white quartz with gray bands, minor pyrite and calcite.
11	do.	xxx	185	1.1	5	4	1	.4	.1	Select dump sample of vein material, white calcite and stringers of white quartz.
12	Chip	36	50	.1	4	23	10	.5	.5	Partially altered latite, feldspars altered to white clay, minor chlorite.

Table 1.--Analytical data and description of samples for gold prospects in and near the Warm Springs Wilderness Study Area, Arizona, not shown in other figures or tables--Continued

No.	Sample		Assay data							Sample description
	Type	Length (in.)	Au ppb	Ag	As	Cu ppm	Pb	Sb	Tl	
13	Chip	10	20	0.1	10	22	8	1.8	0.6	Vein, brecciated calcite, clay, and minor hematite.
14	do.	24	---	.1	2	23	4	1.4	.4	Latite altered to dark gray clay, calcite stringers in fractures.
15	do.	13	5	.1	4	19	8	2.2	.1	Vein, coarsely crystalline white calcite, white clay, brecciated andesite.
16	do.	12	535	.1	3	6	1	.2	.1	Vein, coarsely crystalline white calcite and white quartz stringers, calcite partially replaced by quartz.
17	do.	48	5	.1	3	10	9	.6	.4	Vein, brecciated silicified latite cemented with chalcedony, open vugs filled with botryoidal chalcedony.
18	do.	38	165	.1	7	10	3	1.0	.1	Vein, coarsely crystalline white quartz, calcite, and quartz stringers. Calcite and quartz stringers extend into andesite host rock.
26	do.	13	285	.2	41	28	9	19.2	1.3	Vein, brecciated white quartz and andesite, light-gray quartz stringers, silicified gouge between quartz clasts, minor hematite in fractures, andesite adjacent to vein is fractured with quartz stringers filling the fractures.
27	do.	24	275	.5	3	4	13	3.0	.1	Vein, quartz and calcite bands, quartz is finely crystalline, white with light-gray bands, calcite is white in seams to 4 in. wide.
28	do.	60	175	.1	3	7	5	2.0	.1	Vein, quartz and calcite bands, calcite bands are 1 to 8 in. wide, quartz bands to 1 in. wide, brecciated and silicified latite adjacent to vein, minor hematite in fractures.
45	do.	19	15	.1	71	3	30	6.6	2.3	Vein, coarsely crystalline white quartz, brecciated, silicified trachyte, white calcite stringers in fractures, abundant hematite in breccia clasts.
46	do.	14	15	.1	53	4	12	5.4	1.1	Vein, coarsely crystalline white quartz, brecciated, silicified trachyte, yellow calcite stringers.
47	do.	42	10	.1	190	13	9	130	2.5	Shear zone in latite, numerous fractures filled with chalcedony and calcite, feldspars altered to white clay.
48	do.	36	20	.1	10,000	15	8	40	.3	Vein, brecciated, silicified latite, abundant light-red to white chalcedony bands between breccia clasts, calcite replaced by chalcedony, abundant hematite.

Table 1.--Analytical data and description of samples for gold prospects in and near the Warm Springs Wilderness Study Area, Arizona, not shown in other figures or tables--Continued

No.	Sample		Assay data							Sample description
	Type	Length (in.)	Au ppb	Ag	As	Cu	Pb	Sb	Tl	
							ppm			
49	Chip	30	5	0.1	10,000	6	5	42	.5	Vein, brecciated, silicified latite, abundant massive white quartz between breccia clasts, minor hematite, feldspars altered to white clay, strike N. 38° W., dip 59° NE.
105	do.	18	1,230	1.3	310	26	11	38	1.6	Vein, finely crystalline banded quartz, white, tan, and red-brown banding. Brecciated, silicified latite, minor calcite stringers, hematite in fractures, strike N. 62° E. dip 40° NW.
106	do.	30	170	.1	170	22	16	200	2.0	Vein, brecciated and propylitically altered latite, abundant white clay between breccia clasts, abundant hematite, strike N. 60° W., dip 55° NE.
107	do.	12	---	.1	600	4	2	5	.1	Vein, 12 in. wide, brecciated, silicified latite, finely crystalline banded quartz, white, gray and red-brown banding, minor calcite, yellow and white clay, strike N. 60° E., dip 67° NW.
108	do.	24	---	.1	19	9	13	3.2	1.0	Propylitically altered latite, abundant chlorite.
109	do.	22	60	.1	200	14	35	97	1.2	Vein, brecciated, silicified latite, white quartz stringers, abundant hematite, minor chrysocolla, strike N. 74° W., dip 52° N.
110	do.	24	---	.1	3,700	5	6	57	1.2	Vein, brecciated, silicified latite, bands of white, gray, and red-brown quartz, white clay, strike N. 20° W., dip 69° NE.
111	do.	30	15	.1	19	13	9	7	1.8	Fractured latite with white quartz stringers filling fractures, partial silicification of latite adjacent to quartz stringers.
112	do.	20	140	.1	70	21	11	95	1.5	Vein, brecciated, partially silicified latite, feldspars altered to white clay, calcite stringers filling fractures, abundant hematite in fractures, strike N. 43° W., dip 70° NE.
113	do.	20	5	.1	41	15	5	46	2	Vein, brecciated, silicified latite, feldspars altered to white clay, minor chlorite, light-red-brown finely crystalline quartz and minor calcite fill fractures, strike N. 43° W., dip 70° NE.
114	Grab	xxx	---	.1	41	9	16	200	2.0	Grab from dump at shaft, latite partially altered to white clay, white quartz stringers in fractures, minor white calcite stringers in fractures.
115	Chip	32	<5	.1	90	11	8	12.4	1.6	Fractured latite, feldspars altered to white clay, abundant hematite in fractures.
116	do.	32	<5	.1	53	2	10	9	1.1	Fractured latite, altered to white and tan clay, hematite in fractures.
121	do.	24	---	.1	120	11	1	6.4	.1	Vein, coarsely crystalline gray to white banded calcite with minor white quartz, strike N. 70° W., dip 49° NE.

Table 1.—Analytical data and description of samples for gold prospects in and near the Warm Springs Wilderness Study Area, Arizona, not shown in other figures or tables—Continued

No.	Sample		Assay data							Sample description
	Type	Length (in.)	Au ppb	Ag	As	Cu	Pb	Sb	Tl	
							ppm			
122	Grab	xxx	---	0.1	200	8	1	10.4	0.1	Grab of calcite vein material from dump of caved prospect.
124	Chip	24	---	.1	1	3	2	.1	.1	Vein, coarsely crystalline white quartz in gneiss, gneiss is banded with white quartz, biotite, and orthoclase, isolated pegmatite pods.
125	do.	30	---	.1	3	2	4	.2	.4	Pegmatite in gneiss, abundant quartz and orthoclase.
126	Grab	xxx	---	.1	3	3	6	.1	1.0	Grab of finely crystalline pink orthoclase with pseudomorphs of goethite after pyrite.
127	Chip	12	205	.1	10	17	28	.2	.1	Gneiss, abundant finely crystalline gray quartz, minor hematite.
128	do.	10	1,450	.2	1	3	6	.2	1.4	Pegmatite in gneiss, coarsly crystalline orthoclase, abundant white quartz stringers, minor chlorite and muscovite, strike N. 71° E., dip 63° S.
129	do.	30	10	.1	1	2	1	.2	.1	Pegmatite pod with chloritic gneiss, stringers of white quartz, abundant orthoclase.
130	do.	28	---	.1	4	2	2	.2	.2	Chloritic gneiss, stringers of quartz and orthoclase.
131	do.	24	275	.1	2	12	25	.2	.7	Seam of fine grained pink orthoclase and minor quartz stringers, goethite pseudomorphs after pyrite, strike N. 70° E. dip vertical.
132	do.	30	---	.1	1	10	2	.1	.3	Banded gneiss adjacent to pink orthoclase seam, bands of biotite, quartz, and pink orthoclase.
133	Grab	xxx	490	.1	5	4	6	.2	.8	Select grab of pink orthoclase, pseudomorphs of goethite after pyrite.
134	Chip	36	---	.1	2	14	12	.2	.1	Rhyolite altered to white clay, stringers of white quartz, coarse gypsum crystals in white clay.
135	do.	28	---	.1	3	10	13	.4	.2	Rhyolite altered to white clay, minor pyrite, abundant coarsely crystalline gypsum, minor chalcedony in pods, limonite in fractures.
136	do.	16	---	.1	5	9	12	.9	.2	Rhyolite altered to white clay, minor disseminated pyrite, white to light gray banded chalcedony in pods, limonite in fractures.
137	do.	10	---	.1	2	14	6	.2	.2	Rhyolite altered to white clay, minor disseminated pyrite, abundant coarsely crystalline gypsum, minor white to light-gray banded chalcedony in pods, limonite in fractures.
138	do.	36	5	.1	4	11	15	.2	.2	Rhyolite altered to white clay, stringers of white chalcedony and calcite, limonite in fractures.

Table 1.--Analytical data and description of samples for gold prospects in and near the Warm Springs Wilderness Study Area, Arizona,  
not shown in other figures or tables--Continued

No.	Sample		Assay data							Sample description
	Type	Length (in.)	Au ppb	Ag	As	Cu	Pb	Sb	Tl	
							ppm			
151	Chip	30	---	0.1	7	8	5	0.2	0.2	Vein, highly brecciated, silicified rhyolite, abundant finely to coarsely crystalline white quartz stringers, minor white clay.
152	Grab	xxx	---	.1	2	4	2	.1	.1	Select grab of vein material, white banded chalcedony and minor hematite.
153	do.	xxx	15	.1	2	11	1	.1	.1	Select grab of vein material, finely and coarsely crystalline white quartz, minor hematite.
154	Chip	30	---	.1	11	11	13	.3	.4	Rhyolite altered to white clay, abundant hematite, minor chlorite, white quartz stringers in fractures.
155	do.	18	---	.1	3	12	2	.2	.1	Vein, finely crystalline white quartz, minor hematite.
156	do.	32	5	.1	24	8	2	.2	.1	Vein, brecciated, silicified rhyolite, grains of white clay in breccia clasts, white chalcedony and crystalline quartz stringers, minor hematite.
157	Grab	xxx	---	.1	38	31	3	.2	.1	Select grab of vein material, brecciated, silicified rhyolite, pods of coarsely crystalline white quartz, minor hematite in pods.
158	Chip	32	---	.1	15	12	2	.3	.1	Brecciated, silicified rhyolite, white clay in irregular grains, minor chalcedony.
159	do.	30	15	.1	11	6	1	.1	.1	Vein, brecciated, silicified rhyolite, white clay, minor limonite, strike N. 60° E. dip vertical.
160	Grab	xxx	---	.1	27	9	1	1.6	.1	Fault, silicified andesite, light gray chalcedony stringers, feldspars altered to white clay, abundant hematite in fractures, strike E., dip 45° N.

Table 2.--Analytical data and description of samples 29-44, from the Warm Springs Wilderness Study Area, Arizona.

[Gold and silver determined by fire assay and atomic absorption; antimony, arsenic, copper, lead and thallium determined by inductively coupled plasma analysis. Au, gold; Ag, silver; As, arsenic; Cu, copper; Pb, lead; Sb, antimony; Tl, thallium. ---, analyzed for but below detection limit. Detection limits: Au, 5 ppb; Ag, 0.1 ppm; As, 1 ppm; Cu, 0.1 ppm; Pb, 0.1 ppm; Sb, 0.2 ppm; Tl, 0.1 ppm.]

No.	Sample Length of Chip (in.)	Analytical data							Sample description
		Au ppb	Ag	As	Cu	Pb ppm	Sb	Tl	
29	30	2,250	0.5	39	2	13	4.6	1.7	Fault in brecciated, silicified trachyte, minor quartz stringers, calcite and hematite in fractures.
30	40	40	.1	17	3	12	4.2	1.9	Fault in brecciated and weakly silicified trachyte, minor quartz stringers, calcite, hematite, and white clay in fractures.
31	54	5	.1	11	4	13	19.4	2.1	Fault in brecciated, silicified trachyte, abundant quartz stringers and hematite in fractures, minor white clay, calcite stringers filling fractures.
32	17	105	.1	36	2	12	7.4	2.3	Fault in brecciated, silicified trachyte, quartz, calcite stringers, and minor hematite in fractures.
33	55	25	.1	48	2	10	6.8	1.9	Brecciated, silicified trachyte, abundant hematite and chlorite, minor white clay.
34	51	25	.1	24	2	12	8.6	3.4	Fault in brecciated, silicified trachyte, quartz breccia filling fault, breccia clasts cut by quartz stringers, abundant hematite in fractures.
35	35	795	.1	65	2	16	9.2	3.0	Fault in brecciated, silicified trachyte, abundant white clay in fractures, breccia clasts cut by quartz stringers.
36	22	5	.1	100	3	26	6.6	2.5	Fault in brecciated, silicified trachyte, abundant white clay and silicified breccia clasts.
37	22	720	2.0	29	4	19	8.2	2.6	Fault in brecciated, silicified trachyte, stringers of white quartz fill fault, minor white clay.
38	30	165	.2	36	3	65	6.2	1.7	Brecciated, silicified trachyte with white clay, abundant hematite in fractures.
39	43	150	.5	43	3	32	8.4	3.0	Brecciated, silicified trachyte, abundant quartz stringers and hematite in fractures.
40	34	195	.1	12	2	20	4.4	2.9	Brecciated, silicified trachyte, quartz and calcite stringers in fractures, breccia clasts of white finely crystalline quartz, minor hematite in fractures.
41	48	310	.1	59	2	21	9.6	2.2	Do.
42	18	---	.1	7	2	41	17.4	1.3	Sheared and propylitically altered trachyte, numerous closely spaced faults, abundant chlorite and trace of hematite.
43	31	385	.4	41	2	22	9.2	1.9	Brecciated, silicified trachyte, breccia clasts cut by quartz stringers, abundant hematite in fractures.
44	36	465	.1	39	2	12	6.4	2.6	Brecciated and partially silicified trachyte, breccia clasts of white quartz, calcite stringers in fractures, abundant hematite in fractures.

Table 3.--Analytical data and description of samples 50-104 from the Cook Mine, Warm Springs Wilderness Study Area, Arizona.

[Gold and silver determined by fire assay and atomic absorption; antimony, arsenic, copper, lead, and thallium determined by inductively coupled plasma atomic emission analysis. Au, gold; Ag, silver; As, arsenic; Cu, copper; Pb, lead; Sb, antimony; Tl, thallium. ---, analyzed for, but below detection limit. Detection limits: Au, 5 ppb and 0.001 oz/st; Ag, 0.1 ppm; As, 1 ppm; Cu, 0.1 ppm; Pb, 0.1 ppm; Sb, 0.2 ppm; Tl, 0.1 ppm.]

Sample No.	Length of Chip (in.)	Assay data							Sample description
		Au ppb	Ag	As	Cu	Pb ppm	Sb	Tl	
50	26	---	0.1	1,600	18	12	105	1.3	Latite, propylitically altered, white clay.
51	28	---	.1	60	14	13	120	1.5	Do.
52	24	35	.1	100	18	8	110	1.8	Highly fractured latite, abundant hematite in fractures, partially silicified, feldspars altered to white clay.
53	10	10	.1	35	25	10	54	1.5	Shear in highly fractured latite, calcite and hematite fill fractures in shear, partially silicified with feldspars altered to white clay.
54	30	15	.1	100	15	8	82	1.5	Shear in highly fractured latite, hematite fills fractures in shear, partially silicified with feldspars altered to white clay.
55	30	10	.1	80	13	9	14.8	1.6	Shear in highly fractured latite, minor hematite and calcite fill fractures in shear, partially silicified with feldspars altered to white clay.
56	32	---	.1	61	14	14	7	1.0	Shear in highly fractured latite, hematite fills fractures in shear, feldspars altered to white clay.
57	30	5	.1	41	16	11	6.4	1.6	Shear in highly fractured latite, latite altered to white and brown clay with abundant hematite.
58	18	15	.1	27	15	13	4.6	.3	Shear in highly fractured latite, calcite, minor hematite and chert fill fractures in shear, minor silicification and feldspars altered to white clay.
59	26	---	.1	41	17	11	5.0	.8	Fractured latite, minor hematite in fractures, feldspars altered to white clay.
60	20	---	.1	19	11	5	29	1.4	Fractured latite, abundant hematite in fractures, feldspars altered to white clay.
61	34	55	.1	29	15	6	38	1.6	Shear zone adjacent to fault in latite, minor silicification, brown chert fill fractures, abundant hematite, feldspars altered to white clay.
62	30	5	.1	27	10	3	18.6	1.2	Do.
63	32	20	.1	410	8	4	18.4	.5	Shear zone adjacent to fault in highly fractured latite, complete silicification, abundant brown chert, minor white crystalline quartz and calcite fill fractures.
64	22	10	0.1	170	14	6	28	1.2	Shear zone adjacent to fault in highly fractured latite, hematite and angular, blocky, light-brown chert breccia fills fractures, feldspars altered to white clay.

Table 3.--Analytical data and description of samples 50-104 from the Cook Mine, Warm Springs Wilderness Study Area, Arizona--Continued

Sample No.	Length of Chip (in.)	Assay data							Sample description
		Au ppb	Ag	As	Cu	Pb ppm	Sb	Tl	
65	30	---	0.1	29	10	7	29	1.2	Shear zone in highly fractured latite, minor chert and hematite fill fractures, feldspars altered to white clay.
66	26	15	.1	48	11	3	27	1.7	Shear zone in highly fractured latite, minor brown chert in fractures, feldspars altered to white clay.
67	26	20	.1	400	14	6	46	1.7	Shear zone adjacent to fault in highly fractured latite, hematite and angular, blocky, brown chert breccia fills fractures, feldspars altered to white clay.
68	30	---	.1	53	18	9	31	1.7	Shear zone adjacent to fault in highly fractured latite, abundant hematite in fractures, feldspars altered to white clay.
69	36	---	.1	20	10	6	20	1.5	Highly fractured latite, feldspars altered to white clay, hematite and minor calcite in fractures.
70	15	25	.1	190	13	12	72	2.2	Do.
71	26	25	.1	100	11	12	12.2	1.5	Fault zone in highly fractured latite, hematite and abundant calcite fill fractures, feldspars altered to white clay.
72	30	5	.1	60	13	8	54	1.9	Highly fractured latite, hematite and minor calcite fill fractures, feldspars altered to white clay.
73	6	475	7.2	53	26	13	4	1.4	Vein, banded, finely crystalline quartz, bands of green, white and red-brown quartz, red hematite staining.
74	12	10	.1	24	11	3	39	1.7	Highly fractured and sheared latite, brown and pink chert fill fractures, minor silicification, feldspars altered to white clay.
75	22	---	.1	100	9	1	11.4	1.2	Do.
76	18	20	.1	120	12	7	34	3.0	Fault zone in highly fractured latite, hematite fills fractures, feldspars altered to white clay.
77	18	---	.2	60	12	8	28	2.2	Do.
78	12	0.002 oz/st	.9	150	12	5	11	2.1	Vein, finely crystalline white quartz, wall rock is fractured and silicified latite, minor hematite and pink chert in fractures.
79	24	.258 oz/st	15.2	38	7	7	1.8	.8	Vein, finely crystalline green quartz with white and red brown banding, pods of white calcite, wall rock is fractured and silicified latite.

Table 3.--Analytical data and description of samples 50-104 from the Cook Mine, Warm Springs Wilderness Study Area, Arizona--Continued

Sample No.	Length of Chip (in.)	Assay data							Sample description
		Au ppb	Ag	As	Cu	Pb ppm	Sb	Tl	
80	30	0.004 oz/st	1.8	32	25	7	4	1.4	Vein, light tan chert with light blue and white bands, pods and bands of white calcite, wall rock is fractured and silicified latite.
81	20	---	.1	30	12	8	38	1.4	Fault zone, highly fractured latite, feldspars altered to white clay, minor hematite and calcite in fractures.
82	24	---	.1	60	14	9	61	2.1	Do.
83	22	---	.1	20	14	11	10	1.2	Do.
84	14	---	.1	43	12	16	66	1.6	Fault in highly altered latite, latite altered to light-brown clay, the feldspars altered to white clay, minor chalcedony and abundant hematite in fractures.
85	25	---	.1	11	28	13	3.2	.8	Latite, feldspars altered to white clay.
86	8	---	.1	20	25	17	8.6	.8	Fault filled with fractured latite and veinlets of calcite, abundant hematite in fractures, feldspars altered to white clay.
87	19	20	.1	63	13	10	76	2.1	Fault filled with fractured latite, latite altered to light brown clay, feldspars altered to white clay, abundant hematite in fractures.
88	15	.01 oz/st	5.6	71	24	9	13.4	1.6	Vein, 6 in. wide, finely crystalline green quartz, latite adjacent to vein silicified to red-brown quartz with specks of white clay.
89	32	.004 oz/st	5.9	39	11	6	8.2	1.2	Vein, finely crystalline massive green quartz, pods and stringers of white quartz, latite adjacent to vein silicified red-brown quartz with specks of white clay, minor hematite filling fractures.
90	24	.008 oz/st	2.8	12	10	6	7.0	.7	Vein, finely crystalline white quartz, stringers of green and red mottled quartz, silicified latite with specks of white clay.
91	35	.016 oz/st	3.0	53	15	8	35	1.2	Do.
92	20	.008 oz/st	3.9	53	20	9	55	1.5	Vein, finely crystalline green quartz, silicified latite, specks of white clay and minor hematite in fractures.
93	22	35	.4	180	16	15	140	2.7	Vein, finely crystalline white quartz, hematite stringers, propylitically altered latite.
94	20	.004 oz/st	6.7	69	18	10	140	3.5	Vein, finely crystalline white and red mottled quartz and stringers of green quartz, abundant hematite in fractures.

Table 3.--Analytical data and description of samples 50-104 from the Cook Mine, Warm Springs Wilderness Study Area, Arizona--Continued

Sample No.	Length of Chip (in.)	Assay data							Sample description
		Au ppb	Ag	As	Cu ppm	Pb	Sb	Tl	
95	12	15	0.4	99	12	10	40	3.0	Vein, finely crystalline dark gray, red, and white mottled quartz, silicified latite, abundant hematite in fractures.
96	21	110	.2	90	19	9	120	4.0	Do.
97	30	0.002 oz/st	1.2	200	33	17	100	3.6	Vein, finely crystalline white quartz with red mottling and thin bands up to 4 in. wide of green quartz, abundant hematite in fractures, silicified latite adjacent to vein.
98	40	.008 oz/st	6.4	180	17	10	24	3.2	Do.
99	28	320	.9	80	24	11	120	4.0	Fault filled with brecciated silicified latite, abundant hematite.
100	28	15	.2	200	13	8	90	2.8	Do.
101	24	---	.1	51	17	12	110	2.3	Fault in fractured latite, latite partially altered to dark gray clay, feldspars altered to white clay, abundant hematite in fractures.
102	36	.002 oz/st	.4	110	15	10	81	3.4	Vein, finely crystalline white and red mottled quartz with bands up to 1 in. wide of green quartz, associated silicified latite, abundant hematite in fractures.
103	42	.006 oz/st	4.7	130	19	11	85	2.9	Vein finely crystalline white and red mottled quartz with bands up to 12 in. wide of green quartz, latite adjacent to vein is brecciated and silicified and contains specks of white clay.
104	22	45	.2	130	15	14	100	2.7	Fault filled with brecciated, silicified latite and minor pods of white quartz, feldspars altered to white clay, abundant hematite fills fractures.

Table 4.--Analytical data for samples 117-120, 123 from zeolite prospects in the Warm Springs Wilderness Study Area, Arizona.

[Analytical work by Colorado School of Mines Research Institute, Golden, Colorado.]

No.	Sample		Analytical Results					Amonium Exchange Capacity meq NH <sub>4</sub> /g	Sample description
	Type	Length (in.)	Clinoptilolite	Mordenite	Glass %	Calcite	Quartz		
117	Chip	24	---	---	---	97	3	0.03	Altered latite bed, light-buff, below basalt bed.
118	Grab	xxx	40	30	30	---	---	1.1	Random grab from ripped outcrop of light-buff altered latite, banded with fine to coarse grained texture.
119	Chip	18	40	20	30	---	10	1.1	Chip from 45 ft x 5 ft trench of light-buff, altered latite bed, pink grains and zones of soft, light-green material, quartz grains.
120	do.	18	30	30	29	---	11	1.2	Light-buff, fine-grained, altered latite bed, light-green and pink zones, quartz grains, strike N. 35° E. dip 17° NW.
123	do.	20	30	15	49	---	---	1.3	Outcrop of buff, altered latite.

Table 5.--Analytical data for samples 161-175 from kaolin quarry and prospects in and near the Warm Springs Wilderness Study Area, Arizona.

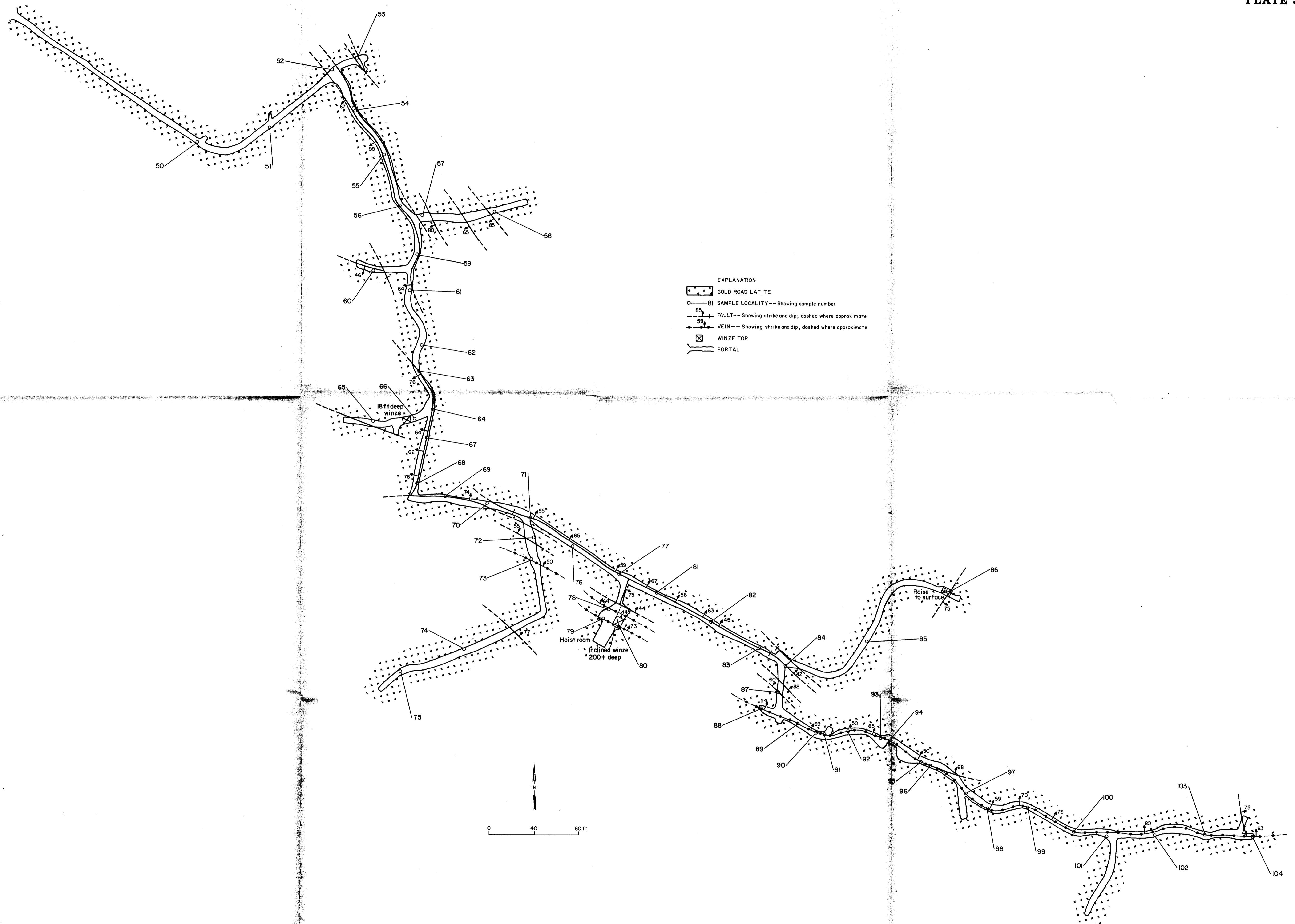
[Analytical work by Colorado School of Mines Research Institute, Golden, Colorado.]

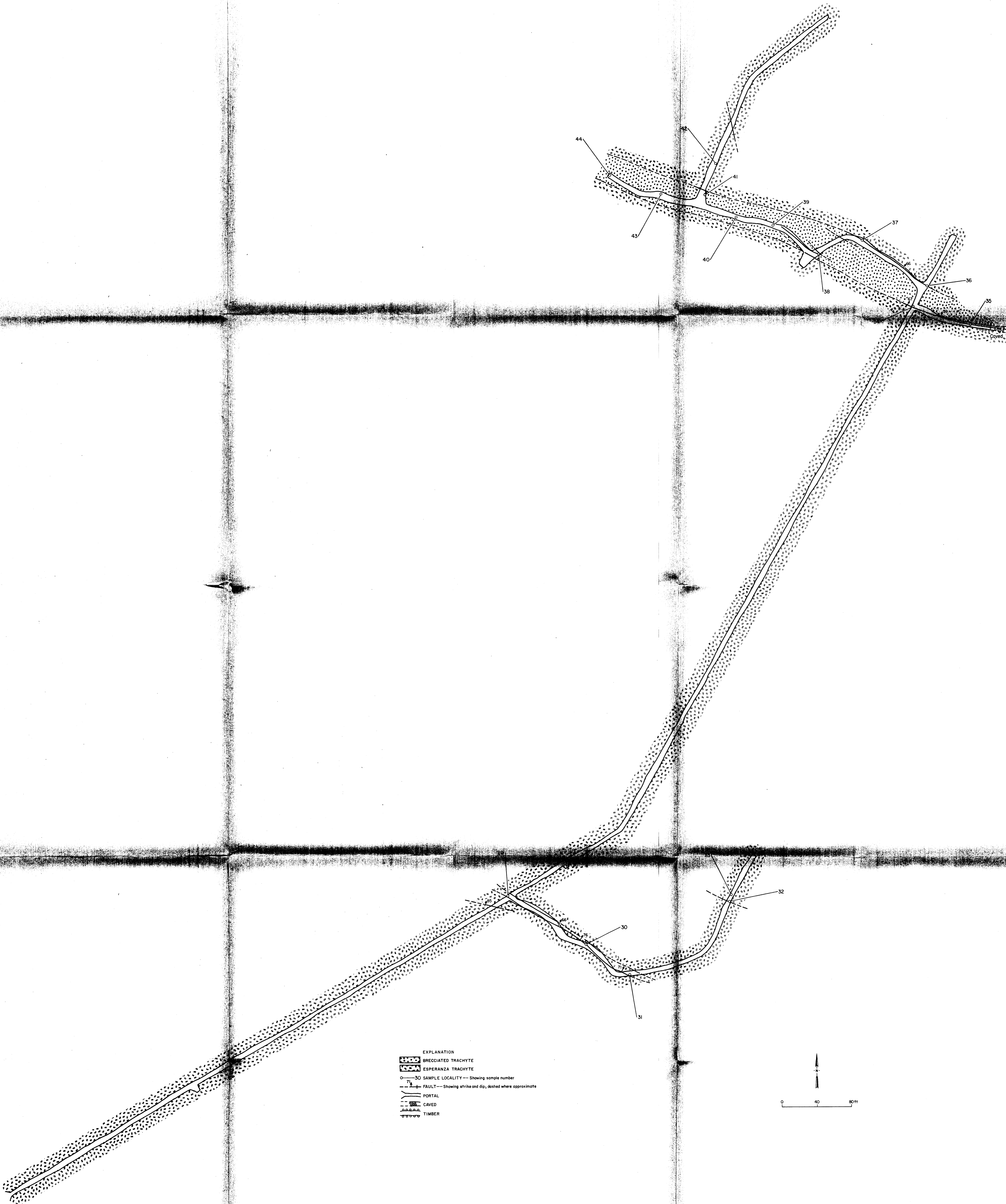
Sample No.	Length of chip (in.)	Analytical results							Sample description
		Kaolin	Smectite	Quartz	Cristobalite	Glass	Clinoptilolite	Mordenite	
%									
161	84	7	20	19	20	19	---	15	Massive white clay contains silicified, brecciated rhyolite and chert fragments, from lower bench of kaolin quarry.
162	80	10	10	12	18	---	---	50	Massive white clay and minor nodules of chert and silicified rhyolite, from lower bench of kaolin quarry.
163	72	7	---	3	25	25	---	40	Do.
164	72	10	25	5	17	43	---	---	Massive white clay, minor silicification, minor chert nodules to 1/4 in., from middle bench of kaolin quarry.
165	78	10	30	7	18	35	---	---	Do.
166	60	10	20	5	20	40	---	---	Massive white clay, minor silicification, from top bench of kaolin quarry.
167	90	---	---	25	5	35	---	35	Silicified, massive, buff rhyolite, minor limonite, minor quartz stringers, from outcrop adjacent to kaolin quarry.
168	96	---	---	18	5	7	35	35	Do.
169	24	---	15	3	8	24	35	20	Massive, partially silicified white clay, chert nodules to 2 in. wide, from outcrop adjacent to kaolin quarry.
170	48	8	20	14	19	39	---	---	Massive, silicified white clay, minor hematite, minor quartz stringers.
171	44	6	10	8	14	42	---	20	Do.
172	48	7	10	5	21	32	---	25	Do.
173	44	8	---	5	15	72	---	---	Silicified rhyolite with pods of white clay, lithic fragments partially altered to white clay, chert nodules, quartz stringers.
174	48	6	---	2	40	52	---	---	Massive, silicified, white clay with purple mottling, lithic fragments partially altered to white clay.
175	24	6	---	6	17	41	30	---	Massive, silicified white clay and cert nodules, quartz strings, minor limonite in fractures, clasts of lithic fragments partially altered to white clay.

Table 6.--Expandability tests and description of samples 176-181 from perlite prospects in the Warm Springs Wilderness Study Area, Arizona.

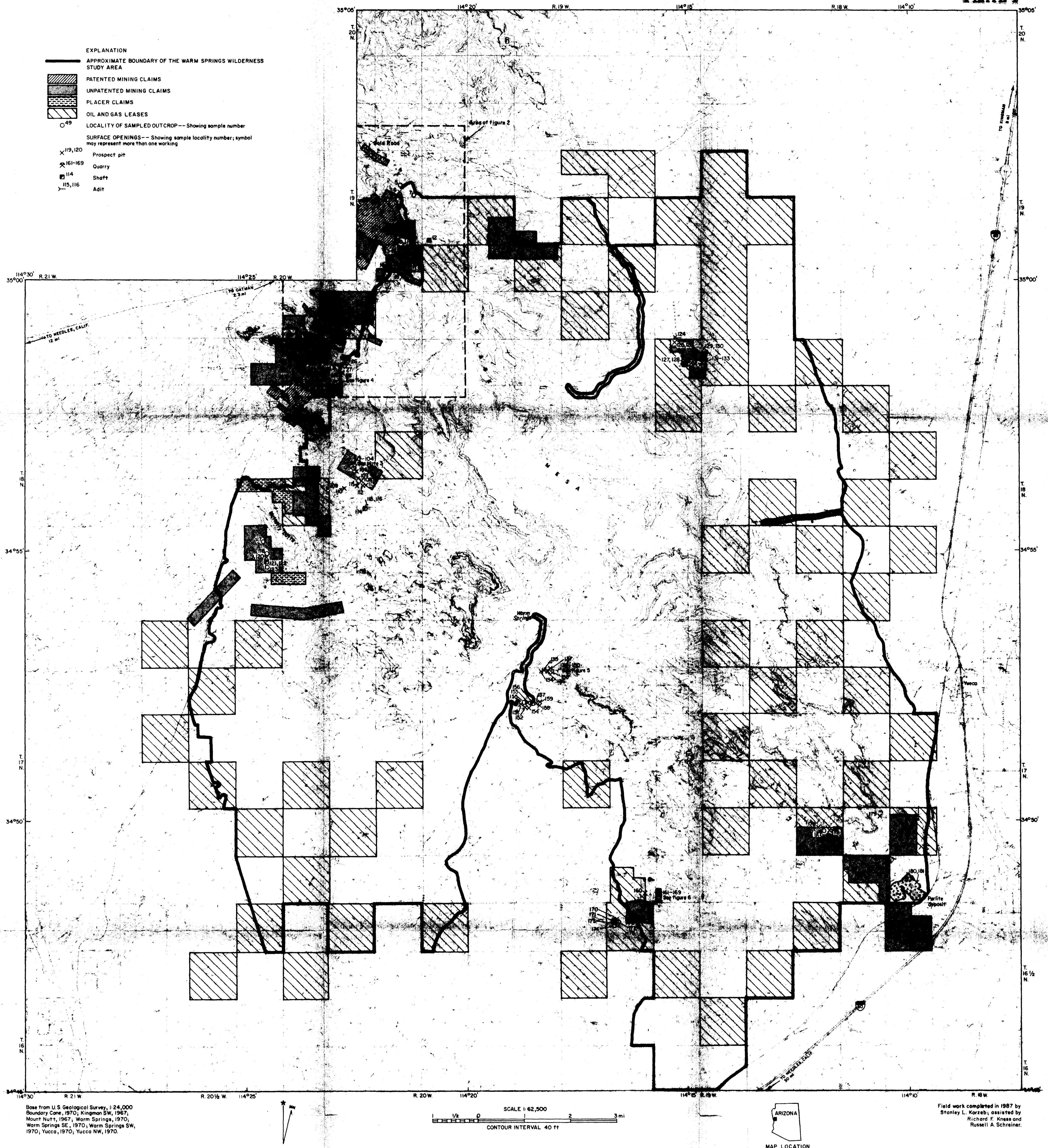
[Analytical work by Perlite Corp., Aston, PA.]

Sample No.	Furnace Temperature (°F)			Furnace Temperature (° F)			Description and results
	0	300	600	0	300	600	
	Sample mass (gm)			Perlite density (Kg/m <sup>3</sup> )			
176	1.6	4.9	2.5	800	1,225	1,250	Chip, 30 in., light tan volcanic glass, chert nodules, insignificant expansion.
177	7.4	12.0	5.1	370	414	182	Chip, 12 in., dark green black volcanic glass, chert nodules and rhyolite bands, very poor expansion, dark gray product.
178	3.9	3.8	3.6	650	1,900	3,600	Chip, 48 in., light tan volcanic glass, insignificant expansion.
179	6.9	8.6	8.2	150	183	222	Chip, 36 in., light tan to light gray volcanic glass, poor but uniform expansion.
180	5.0	6.6	8.2	50	66	80	Random chip from 15-ft-thick bed exposed in cut, light-to dark-gray volcanic glass, dark-gray rounded blebs of volcanic glass in light-gray volcanic glass matrix, all but fines expanded well with snapping.
181	3.8	3.4	5.2	39	33	51	Random chip from 6-ft-thick bed exposed in upper part of cut, light to dark gray volcanic glass, glass breaks into rounded balls to 1/4 in. in diameter, expanded well with lively snapping, producing a glossy white product.





MAP OF ADIT SHOWING SAMPLE LOCATIONS 29-44, TABLE 2 SHOWS SAMPLE DATA



# MINE AND PROSPECT MAP OF THE WARM SPRINGS WILDERNESS STUDY AREA, MOHAVE COUNTY, ARIZONA

BY  
STANLEY L. KORZEB, U.S. BUREAU OF MINES

1988